Center Independent Research & Development: JPL IRAD

Next-generation Miniaturized Thermal Imagers Based on Advanced Thermoelectric Materials and an Innovative Ultra-compact Optical Design

Completed Technology Project (2016 - 2018)

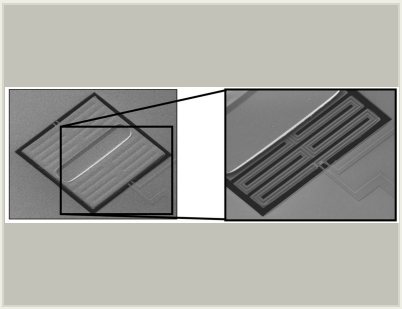
Project Introduction

The proposed work promises to increase the sensitivity of JPL's thermopiles by 5x. One of JPL's most important product line instruments is the remote-sensing multi-spectral thermal imager (TI) using uncooled thermopiles arrays. Infrared remote sensing has a long history in planetary exploration, providing temperature and compositional information for the terrestrial planets and airless bodies, and probing the atmospheres of the giant planets and Mars.

Our proposed miniaturized thermal imager will enable the next generation of JPL TI with a **5x greater sensitivity and a 2x larger field-of-view** with a 2× larger filter block thus accommodating up to **2× more spectral channel**s embedded in an **optical bench 2× smaller** than an equivalent conventional design and with increased optical performance. This compact design will enable JPL thermal imagers to map scientific targets at higher resolution than ever before, with very high sensitivity in multiple spectral bands, and also make this miniature passively cooled instrument an attractive choice for future NASA missions to a broad range of planetary targets. Microbolometer arrays developed for night vision are commercially available and have been used on two space instruments (THEMIS on Mars Odyssey and the ISAR shuttle instrument) and under development to fly on the planned Europa Clipper mission (E-THEMIS). Microbolometers are intrinsically very sensitive to substrate temperature variation, making strict focal-plane temperature control essential. However, recent advances in electronics and materials allow microbolometer to operate at room-temperature with comparable performance with respect to JPL's thermopiles. The goal of this work is to advance JPL's thermopile program in order to be ahead of the competition.

Anticipated Benefits

The improved thermopile technology will be proposed for several future New Frontiers (e.g. Trojan Tour and Rendezvous, Coment Surface Sample Return, Io Observer) and Discovery (e.g. BASiX) mission concepts. This would increase the NASA Science Return for the aforementioned missions.



(LEFT) Micrograph of 100x100 um2 pixels built and characterized in MDL. (RIGHT) If the silicon nitride absorber is removed, then the thermoelectric lines on silicon nitride support beams are exposed.

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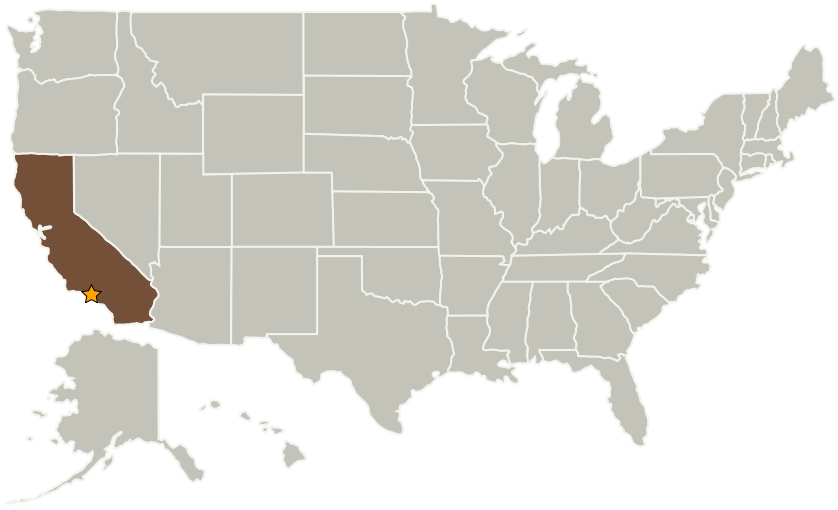
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Independent Research & Development: JPL IRAD

Project Management

Program Manager:

Fred Y Hadaegh

Project Manager:

Fred Y Hadaegh

Principal Investigator:

Giacomo Mariani

Co-Investigators:

Sabah K Bux
William R Johnson
Matthew E Kenyon

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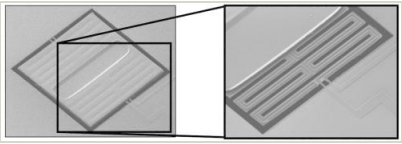
Images

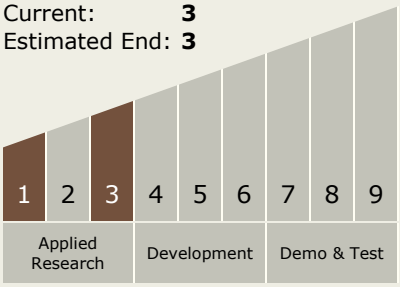


JPL_IRAD_Activities Project Image

(LEFT) Micrograph of 100x100 um2 pixels built and characterized in MDL. (RIGHT) If the silicon nitride absorber is removed, then the thermoelectric lines on silicon nitride support beams are exposed. *(https://techport.nasa.gov/image/27871)*

Technology Maturity (TRL)

Start: **1**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.1 Detectors and Focal Planes

Target Destinations

Others Inside the Solar System, Foundational Knowledge

Supported Mission Type

Projected Mission (Pull)